Update/Le point

Intestinal parasitic infections and urbanization*

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About a third of the population in the cities of developing countries live in slums and shanty towns. By the year 2000 it is estimated that this number will grow to 2200 million, and by 2025 about 57% of the population in developing countries will be in urban areas. The prevalence of infections caused by Entamoeba histolytica *and* Giardia intestinalis *and the prevalence and intensity of* Ascaris lumbricoides *and* Trichuris trichiura *infections may increase among the rural populations who are migrating to these urban and suburban settings owing to the favourable conditions for transmission. Urgent consideration should therefore be given to improving sanitation in deprived urban areas and to treating periodically these populations to reduce the worm burden, especially in school-age children.*

Introduction

In developing countries, urbanization results from the unplanned, uncontrolled and constant migration of people from the rural areas to urban settlements (*1*).[a] As early as 1968, Nnochiri described the public health problems that urbanization was already causing in Nigeria, particularly with regard to parasitic infection and the provision of health care (*2*). This type of migration appears to be irreversible, with waves of illiterate, unskilled, poor people leaving the countryside in search of work in the cities. The increase in population in developing countries is causing this flow of people to the cities to deplete the countryside of the required labour force to grow the crops for national nutritional needs as well as export (*3*).

This article describes some of the health problems confronting millions of rural migrants to the slums, shanty towns, and squatter settlements in the urban and periurban environments of developing countries. Similar health problems have existed among poor people in the cities of developing countries even before urbanization became the force that it is today. Many of the present residents of the urban slums were actually born there and, together with the recently arrived rural people who are trying to adapt to the urban situation, they form a group that is relegated to the margins of social, political and economic activity. Both the migrants and the long-established slum-dwellers carry the burden of intestinal parasitic diseases because the meagre resources of the city authorities are overstretched and their services for water supply, sanitation, garbage disposal, health care and hygiene are inadequate. For example, of the 7 million inhabitants of Dhaka, Bangladesh, about 3.5 million live in slums and only 6% of them have access to primary education and 3% to primary health care (*4*).

Two questions of major public health significance for the urban poor are discussed below.

- What is the current state of intestinal parasitic infections for people living in the urban slums of developing countries?
- What can be done to establish programmes with the objective of improving the health of these gravely deprived people?

The present situation

Types of intestinal parasitic infections

According to Bradley et al. (*5*), many surveys have demonstrated a high prevalence of intestinal parasitic infections in children of slums, shanty towns and squatter settlements. This generalization results part-

* A French translation of this article will appear in a later issue of the *Bulletin*.

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[a] **Kan, S.P.** *Effects of urbanization on intestinal parasitism.* Unpublished WHO document PDP/EC/WP 86.20, 1986.

Reprint No. **5348**

ly from the availability of relatively simple, quick, cheap and accurate diagnostic techniques (*6, 7*), and partly from the importance of these infections as determinants of child health.

Common parasites found in the human alimentary tract are listed in Table 1. Of these, the protozoan parasites *Entamoeba histolytica* and *Giardia intestinalis* and the helminths *Ascaris lumbricoides* and *Trichuris trichiura* appear to be the most frequently encountered in urban communities. *Necator americanus* is an extremely common species of hookworm (*8*), but it is more often found in rural communities where the environmental conditions favour the development of its free-living stages. Results of a selection of epidemiological surveys of the prevalences of *E. histolytica, G. intestinalis, A. lumbricoides* and *T. trichiura* in urban slum-dwellers are presented in Table 2 and features of the biology of these four species of parasite, together with information about the diseases they initiate and recommended treatments, are given in Table 3.

Each of these species (Table 3) has a direct life history, being transmitted from human to human by the faeco-oral route during which cysts or eggs are discharged in human stools. Widespread contamination of the environment occurs and eventually infective stages are swallowed by new hosts. Lack of sanitation, shortage of clean drinking water, poor standards of public and personal hygiene and inadequate health education serve to promote the spread of such parasites. Perhaps more information has been obtained about the transmission of *A. lumbricoides* than the other three parasites described in Table 2. It is estimated that each adult female worm lives for about 1 to 2 years and has a fecundity rate of about 134 000 to 360 000 eggs per day for a period of about 300 days. Consequently, vast numbers of eggs of *A. lumbricoides* are discharged into the human environment daily and, in places where sanitation and safe garbage disposal are non-existent, the environment becomes thoroughly contaminated and infection is difficult to avoid. Some idea of the extent of environmental contamination with the eggs of *A. lumbricoides* and other intestinal helminths is given in Table 4. Vegetables that are grown in rural areas are likely to be contaminated owing to the use of fertilizers prepared from human excrement or untreated sewage effluents. Legislation preventing the use of untreated human excrement as a fertilizer has been found to be accompanied by a marked reduction in the prevalence of intestinal infections (*9*). Cysts of *E. histolytica* and *G. intestinalis* are contaminants of the urban-slum environment and are frequently found in drinking-water supplies; *G. intestinalis* infections also present a health risk in some developed countries.[b]

Table 1: **Common parasites of the human intestinal tract**

Protozoa	
Rhizopodea (amoebae):	
Dientamoeba fragilis	*E. histolytica*
Entamoeba coli	*Endolimax nana*
E. hartmanni	*Iodamoeba butschli*
Helminths	
Platyhelminthes (flatworms)	
Trematoda (flukes):	
Fasciolopsis buski	*Opisthorchis sinensis*
Heterophyes heterophyes	(= *Clonorchis sinensis*)
Metagonius yokogawai	*Schistosoma japonicum*
Opisthorchis felineus	*S. mansoni*
Cestoda (tapeworms):	
Diphyllobothrium latum	*Vampirolepis nana*
Taenia solium	(= *Hymenolepis nana*)
Taeniarhynchus saginatus (= *Taenia saginata*)	
Zoomastigophorea (flagellates):	
Chilomastix mesnili	*Trichomonas hominis*
Giardia intestinalis (= *G. lamblia*)	
Ciliata (Ciliates):	
Balantidium coli	
Nematoda (roundworms):	
Ancylostoma duodenale	*Necator americanus*
Ascaris lumbricoides	*Strongyloides stercoralis*
Enterobius vermicularis	*Trichuris trichiura*

The environment of the urban poor

Intestinal parasitic infections persist and flourish wherever poverty, inadequate sanitation, insufficient health care and overcrowding are entrenched. Ascariasis is a mirror of socioeconomic status, a reflection of environmental sanitary practices and an indicator of the presence, or lack, of health awareness and health education. In the poor urban habitations environmental factors promote the survival and transmission of intestinal parasites and aggravate or alleviate the impact of these infections on the people. The conditions that prevail in urban slums are summarized in Table 5 and the description by Auer (*10*) of a squatter area in Manila provides an example of how to present information in a manner that helps to explain parasite transmission.

[b] *Report of an Informal Consultation on Intestinal Protozoal Infections.* Unpublished PAHO/WHO document WHO/CDS/IPI/92.2, 1992.

Table 2: **Results from epidemiological surveys of intestinal parasitic infections in poor periurban and urban communities in developing countries**[a]

	Prevalence (%)			
	Amoebiasis	Giardiasis	Ascariasis	Trichuriasis
Braganca Paulista, Brazil (*18*)[b]	7	13	30	39
Hyderabad, India (*19*)	9	32	35	–
Nairobi, Kenya (*20*)	41	30	82	60
Kuala Lumpur, Malaysia (*21*)	–	–	64	84
Coatzacoalcos, Mexico (*22*)	–	–	55	55
Lagos, Nigeria (*23*)	8	–	68	72
Manila, Philippines (*10*)	21	20	80	92
Freetown, Sierra Leone (*24*)	–	27	43	81

[a] Causative agents: amoebiasis (*E. histolytica*), giardiasis (*G. intestinalis*), ascariasis (*A. lumbricoides*), and trichuriasis (*T. trichiura*).
[b] Figures in italics in parentheses are the references to the sources.

Table 3: **Features of four common intestinal parasitic infections in people living in urban communities in developing countries**

	Amoebiasis	Giardiasis	Ascariasis	Trichuriasis
Causative agent	*Entamoeba histolytica*	*Giardia intestinalis*	*Ascaris lumbricoides*	*Trichuris trichiura*
Global prevalence (millions)	500	200	1000	800
Infective stage	Quadrinucleate cyst	Cyst	Egg, containing second larval stage	Egg, containing first larval stage
Usual location in humans	Crypts of caecum and colon; may invade liver	Mucosal surface of duodenum	Early larvae undergo migration via liver, adults in jejunum	Mucosa of large intestine, especially of the colon
Parasitological diagnosis	Spherical cysts detected in stools; trophozoites observed in dysentery cases	Oval-shaped cysts detected in stools (erratic release)	Eggs in stools	Eggs in stools
Clinical diagnosis	Diarrhoea, blood and mucus in stools, abdominal pain, chronic fatigue	Persistent diarrhoea, steatorrhoea, anorexia, epigastric pain	Abdominal pain, nausea, anorexia, respiratory complications	Diarrhoea, finger clubbing, stool blood, rectal prolapse
Morbidity	Fulminating colitis, liver abscess, weight loss	Malabsorption, weight loss	Nutritional disturbance, acute complications, e.g., biliary and intestinal obstructions	Chronic colitis, anaemia, reduced growth rate
Treatment	Metronidazole	Metronidazole	Levamisole, mebendazole, pyrantel	Mebendazole

According to Harpham & Stephens (*11*), about a third of the population of the cities in developing countries live in slums and shanty towns and, by the year 2000, perhaps as many as 2200 million people will inhabit these cities. No fewer than 24 of the world's cities will have at least 10 million inhabitants each and nine of them will be located in developing countries (Table 6). By the year 2025, about 57% of the population of developing countries will be living in cities if current trends continue (*3, 11*). The only foreseeable benefit for the countries experiencing urbanization is the indication, based on data obtained by the World Fertility Survey for 29 developing countries, that city life may be conducive to smaller families (*12*).

Actions for control

There is a general consensus that modern chemotherapy offers a reliable and effective means of reducing the intensity of intestinal helminth infections like *A.*

Table 4: **Some observations on the distribution of the infective stages of soil-transmitted helminths in the urban environment**[a]

Location	Observation[b]
Kingston, Jamaica (*25*)[c]	Soil: a study of spatial and temporal distribution of *A* and *T* eggs in soil
Shillong, India (*26, 27*)	Soil in children's parks: 7/31 samples positive for eggs of *A, An, E* and *To*
Maradia, Bangladesh (*28*)	House dust: 11–67% of samples positive for *A* eggs; assumed to be dispersed by the wind
Tokyo, Japan (*29, 30*)	Vegetables: 1178/2750 positive for *A* eggs from rural sources; since 1966, no *A* eggs have been detected
Jakarta, Indonesia (*31*)	Finger-nail clippings from children in orphanages: positive for *A* and *E* eggs
Slums in Kuala Lumpur, Malaysia (*32*)	Flies (Diptera): *Musca sorbens* from garbage dumps and households, 229/234 positive for *H* eggs and larvae; *Chrysomya megacephala* and *C. rufifacies*, *A, H* and *T* eggs
Ibadan, Nigeria (*30*)	*Gari* and palm wine (traditional drinks): 7/36 and 5/29 positive for *A* eggs

[a] These examples indicate the dispersal and distribution of the eggs and larvae of soil-transmitted helminths in the human environment, in addition to the eggs present in human stools. Evidence exists for the presence of eggs and larvae on or in chopping boards, door knobs, furniture, money, nasal discharges, pickles, rice fields, septic tanks, sewage, swimming pools, underclothing and washbasins.

[b] Abbreviations—*A*, *Ascaris lumbricoides*; *An*, *Ancylostoma* sp.; *E*, *Enterobius vermicularis*; *H*, hookworm; *T*, *Trichuris trichiura*; *To*, *Toxocara* sp.

[c] Figures in italics in parentheses are the references to the sources.

lumbricoides and *T. trichiura* (*13*).[c] These drugs may be used in the community on either a mass, targeted or selective basis, with the reduction in intensity or mean worm burden per person as the objective since this ought to be accompanied by reductions in the severity of acute and chronic morbidity (Table 3) and in the number of helminth eggs being discharged into the environment. Chemotherapy targeted at schoolchildren appears to be an attractive strategy for beginning the control of *A. lumbricoides* and *T. trichiura* (*14, 15*) because children harbour significantly more worms, on average, than adults and experience more morbidity (Table 3). In addition, the intensity of *A. lumbricoides* infection, measured indirectly as the numbers of eggs per gram of stool, has been observed to fall in the untreated section of the population of a rural Nigerian community (*14*). Methods for delivering chemotherapy to poor urban populations under the various systems of primary health care need to be developed.

The progress made by the use of anthelmintic drugs for the reduction of morbidity and for the control of ascariasis and trichuriasis (Table 3) in poor urban communities needs to be supported by the provision of safe, affordable and culturally acceptable means for the disposal and treatment of human excrement. The same conclusion can be drawn in the case of intestinal protozoan infections. Modern sanitation removes not only the eggs and larvae of intestinal helminths but also the infectious agents of amoebiasis and giardiasis (Tables 1–3) and of the microorganisms that cause diarrhoeal disease. The provision of modern sanitation and sewerage in the cities of developing countries is a massive challenge, given the scale of the current problem which is likely to increase during the next decade. Crude estimates of the daily faecal production of the populations of developing countries by the year 2000 are given in Table 7. Conservative estimates are also given of the outputs of eggs of *A. lumbricoides* which might accompany this discharge of faecal material. The poor inhabitants of urban slums will not be safe from the agents of intestinal parasitic disease and of diarrhoeal disease until sewerage has been installed and is in service with reliable maintenance.

Some inkling into the scale of the problem of providing sewerage can be gained by considering the situation that might develop in a large conurbation like Lagos, Nigeria. If population projections are correct (*16*), by the year 2000 there may be as much as an additional 1240 tonnes of human stool being deposited daily in the areas of Lagos (Table 6) where the poor people live. This figure depends on the reliability of demographic projections based on population census data. There is now reason to believe that the population of Nigeria has been overestimated (*17*). A more realistic set of figures for the situation in Lagos at present is given in Table 7, based on results of the recent census. Regardless of the accuracy of the figures, an enormous problem will face the municipal authorities in many developing countries as regards the removal of human waste.

Some idea of the costs of sewerage installation (*1*), which requires a piped water supply, has been

[c] *Report of an Informal Consultation on Intestinal Helminth Infections.* Unpublished WHO document WHO/CDS/IPI/90.1, 1990.

Table 5: **Examples of socioeconomic conditions in urban slums**

Location	Economic information	Sanitation	Housing	Water supply
Squatter area, Smokey Mountain,Manila, Philippines (*10*)[a]	Selling recyclable garbage, <3500 pesos per month for family of 6 (>99% of families below this poverty line)	2–10% of houses have a latrine	Area 3 x 3 m, 6 people/house, plywood, plastic, iron sheets, cartons	16 faucets
Shanty town of Vila Recreiro, State of São Paulo, Brazil (*33*)	Average monthly earnings: US$ 16 per working person US$ 110 per family	No sewage system	Inadequate	Inadequate
Two divisions of shanty town, Coatzacoalcos, Mexico (*22*)	—	70% defecate in the open air (40% of homes have some facility)	Corrugated iron and concrete blocks, 1–26 people per household (mean 5.5)	Standpipes and drainage canals
Squatter area, Kuala Lumpur, Malaysia (*21*)	Average household income; <$250 per month per family	5–7 families/latrine; children <10 years defecate around the home	Houses on stilts over swamps	6 standpipes for 1200 families
Slums in Dhaka, Bangladesh (*34*)	Work as labourers: c. Rs 94 per family per month	Shallow ditches with temporary fencing	c. 4.5 people per room	Taps and surface water

[a] Figures in italics in parentheses are the references to the sources.

given by J. Pickford (personal communication, 1991) who reckons that the expenditure may be equivalent to as much as US$ 1000 per head of population in a city like Lagos. If modern sewerage of the type found in developed countries were to be made available for the poor population of Lagos by the year 2000 (Table 7), the costs of installation could be as much as 1000 million or more US dollars at current prices. Collection and removal of human excrement from residential areas do not render it safe from being a source of the agents of infectious disease; treatment is also necessary. In Strathclyde Region, Scotland, with a population of about 2 million people, roughly 1.8 million tonnes of sewage sludge are generated annually at the region's 107 sewage treatment works. Eventually, most of this treated waste is dumped at sea at a cost of about US$ 2.00 per tonne while the smaller amount that is used for agricultural and forestry purposes costs about US$ 6.00 per tonne to produce (T.A. Anderson, personal communication, 1991). These figures and the data given in Table 7 suggest that much consideration needs to be given as a matter of urgency to the problem of the disposal and safe treatment of human excrement from urban slums. Progress has been made in developing a variety of latrines for rural communities, but these may not be appropriate for slums and squatter settlements where land for dwellings is scarce.

Table 6: **Thirteen largest cities (in rank order for 1985) in countries with an under-5-years mortality rate (U5MR) of >95 per 1000 live births**[a, b]

	National U5MR (1986)	Projected population (millions) of cities in 2000	GNP US$ (1985)
Calcutta (India)	154	15.94	270
Bombay (India)	154	15.43	270
Cairo (Egypt)	131	11.77	610
Jakarta (Indonesia)	122	13.23	530
Teheran (Iran)	—[c]	13.73	—[c]
Delhi (India)	154	12.77	270
Karachi (Pakistan)	170	11.57	380
Lagos (Nigeria)	178	12.45	800
Madras (India)	154	7.85	270
Dhaka (Bangladesh)	193	11.26	150
Baghdad (Iraq)	98	7.66	—[c]
Bangalore (India)	154	7.67	270
Lahore (Pakistan)	170	5.93	380

[a] Based on data from references *16* and *35*.
[b] U5MR is defined as the number of children who die before the age of 5 for every 1000 born alive.
[c] Data not available.

Conclusion

Permanent protection from the extensive and chronic diseases caused by intestinal parasitic infections will not be secured for the millions of residents of the urban slums in developing countries until clean environments are available. Temporary relief can be obtained by the use of antiprotozoal and anthelmintic drugs and there is the prospect of some reduction in the risk of infection as the health education drive, offered through the primary health care systems, takes effect. This public health problem in the urban slums of developing countries is a matter of great

Table 7: **Factors influencing the persistence of *Ascaris lumbricoides* in urban communities in developing countries**

Estimates for 1990[a]	
Population	2500 million
Daily faecal output of population	500 000 tonnes
No. infected with *A. lumbricoides*	1000 million
Daily faecal output contaminated with eggs of *A. lumbricoides*	200 000 tonnes
Daily discharge of eggs of *A. lumbricoides*	2×10^{14} eggs
Population of urban communities	750 million
Daily faecal output of urban population	150 000 tonnes
No. of urban people infected with *A. lumbricoides*	300 million
Daily faecal output contaminated with eggs of *A. lumbricoides* in urban communities	60 000 tonnes
Daily discharge of eggs of *A. lumbricoides*	6×10^{13} eggs
Estimates for urban communities in the year 2000 [a, b]	
Population	2200 million
Daily faecal output	440 000 tonnes
No. infected wityh *A. lumbricoides*	880 million
Daily faecal output contaminated with eggs of *A. lumbricoides*	1760 000 tonnes
Daily discharge of eggs of *A. lumbricoides*	1.76×10^{14} eggs
Estimates for the conurbation of Lagos, Nigeria, in 1991 [b, c]	
Population	5.7 million
No. of slum and shanty dwellers	2.85 million
Daily faecal output of poor people	570 tonnes
Daily faecal output contaminated with eggs of *A. lumbricoides*	2.9×10^{11} eggs

[a] 1. World's population in 1990 was about 5000 million with about half living in developing countries (about 70% rural and 30% urban communities) (see recent issues of *The state of the world's children* (UNICEF), Oxford University Press).
2. Assumed that about 1000 million people in developing countries are infected with *A. lumbricoides* (*8*).
3. About 200 g stool produced per person daily.
4. About 1000 eggs of *A. lumbricoides* present daily in each gram of stool from an infected person.

[b] Assumed that the prevalence of *A. lumbricoides* will not have changed and that overall the proportion of infected people in rural and urban communities will be the same.

[c] 1. Based on the results of the Nigerian 1991 census.
2. Perhaps as many as 50% of the population of Lagos may constitute the urban poor.
3. Various estimates suggest that >50% of the population of Lagos may be infected with *A. lumbricoides*.

concern and attention should be given now to developing systems for the collection, removal and treatment of the mass of garbage and excrement that accumulates around the homes of these neglected people. Reliable information about the demographic aspects of urbanization is needed to implement this proposal.

Acknowledgements

We are most grateful to S.O. Asaolu, Obafemi Awolowo University, Ile-Ife, Nigeria for his advice and comments. We thank T.A. Anderson, J. Pickford and K. Vickerman for helpful discussions and M.L.N. Murthy for preparation of the typescript.

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